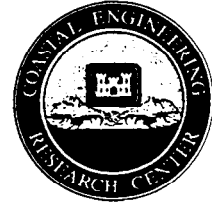
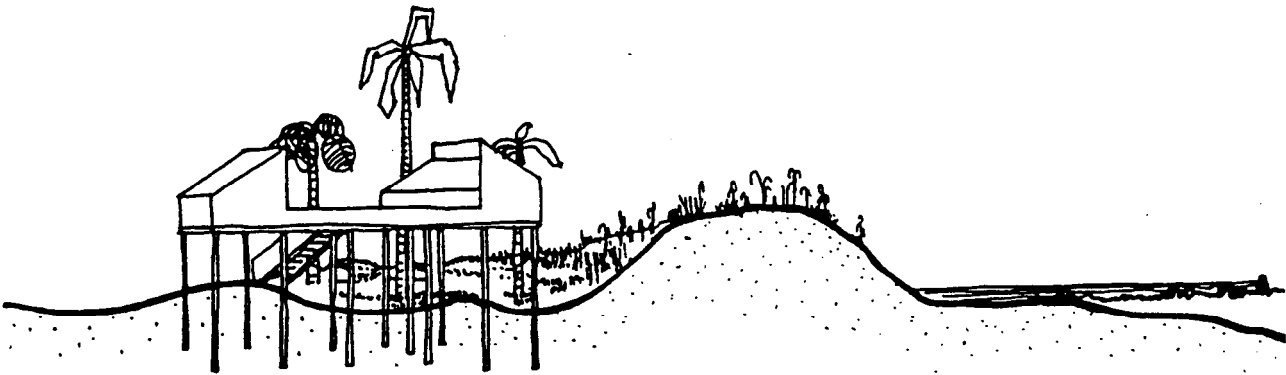




Coastal Engineering Technical Note



DESIGN AND CONSTRUCTION PRACTICES FOR COASTAL BUILDINGS



PURPOSE: This tech note provides coastal field offices with some information on recommended coastal design and construction practices which may be useful to existing or potential coastal property owners. It is not the intent of this tech note to encourage building in high-hazard coastal areas. When such building does or must occur, this information, if appropriately used, will reduce structural damage.

CONSIDERATIONS: The two basic considerations of buildings in coastal areas are (1) protecting existing buildings against wind, storm surge, and wave forces and (2) minimizing structural damage to new construction from these same forces.

(1) **Protecting Existing Buildings:** Buildings located too close to the shoreline can be threatened by erosion as well as by wind, surge, and waves during storms. While building relocation may be the most feasible solution, this alternative may not be acceptable to property owners. Renovation of some existing structures may provide adequate protection, or structures such as bulkheads, seawalls, and revetments can be used to protect existing buildings. However, bulkheads and seawalls strong enough to provide protection from severe storms may be very expensive and may actually accelerate erosion on

their water side. Riprap revetments are normally more affordable but may not provide adequate protection; revetments also require more land since they are constructed on a slope. Groins or beach-fills are not applicable unless an extended shoreline is to be protected.

(2) Minimizing Damage to New Construction: Coastal construction requires special consideration, including the following structural characteristics: adequate foundations; strong connections between structural elements; and hurricane-resistant door frames, window frames, and storm shutters.

Basic construction materials (wood, masonry, concrete, and steel) can be used for building in coastal areas if buildings are properly designed and constructed. Pressure-treated wood can be an excellent material for lowrise (one- and two-story) buildings. The most important requirements for wood-frame construction are connections and anchors which will withstand lateral and uplift wind forces. Special care should be taken to securely anchor the wood structure to the foundation; this is generally accomplished using pilings.

Masonry construction is suitable for low to midrise buildings (up to eight stories). Blocks should be reinforced with horizontal and vertical steel.

Reinforced concrete and protected steel can be used to construct taller buildings with the ability to resist hurricane forces. These buildings are generally constructed with shear walls (thick, reinforced concrete walls) placed strategically throughout the building.

Proper siting is very important when building on the coast. The possibility of severe storms occurring is a special concern; although relatively mild conditions may have prevailed in an area recently, that may not always be the case. It is not a good practice to knock down existing sand dunes since they are one of nature's protective barriers. The consequences of erosion should be considered before developing coastal property. Be wary of developing property near an inlet or at previous inlet locations. Inlets are subject to migration; new inlets can break through and old ones close within a few hours during severe storms.

Designers often are more familiar with inland-type buildings where storm surge and wave forces need not be considered. Therefore building codes written specifically for the coastal area should be adhered to and construction should follow designs precisely. Comprehensive inspection during

construction is especially important in coastal areas.

TECHNICAL GUIDANCE: Technical literature which is available to provide design and construction guidance includes the following items:

- (1) The Shore Protection Manual (1977) provides guidance for the functional and structural design of shore protection structures. It contains comprehensive design criteria on the forces which need to be considered for the construction of coastal buildings. These forces include wind, storm surge, and wave forces.
- (2) Coastal Engineering Technical Notes on shore protection structures (1981) include CETN-III-7 on bulkheads, CETN-III-8 on seawalls, CETN-III-9 on revetments, and CETN-III-6 which compares these different structures.
- (3) The Florida Marine Advisory Bulletins, "Hurricane-Resistant Construction for Homes" (1976) MAP-16 and "Coastal Construction Practices" (1982) Map-23, provide guidance especially applicable to the southeastern United States. A single free copy of these bulletins may be obtained by writing: Sea Grant Marine Advisory Program, G022 McCarty Hall, University of Florida, Gainesville, Florida 32611; or by calling (904) 392-1771. Give the bulletins' names and numbers.
- (4) Guidance for all the coastal regions of the U.S.A. is included in "Design and Construction Manual for Residential Buildings in Coastal High Hazard Areas," a publication of the U. S. Department of Housing and Urban Development and the Federal Emergency Management Agency. A single free copy may be obtained by writing: Federal Emergency Management Agency, P. O. Box 8181, Washington, D. C. 20024. Give manual name and number (FIA-7) when requesting a copy. This 189-page manual, referred to as the FEMA Manual, is summarized below:

Chapter 1 discusses the purpose and scope of the manual and the National Flood Insurance Program. The FEMA manual is intended for use by designers, home builders, community leaders, and local officials. Potential homeowners who wish to build prudently in high-hazard areas and meet the requirements of the National Flood Insurance Program will also find the manual useful. The construction details, design procedures, and charts included are based upon a comprehensive evaluation of many existing beach houses, current construction practices along U. S. coastlines, and various building codes applicable to coastal construction.

Chapter 2 describes the coastal regions of the United States. This

includes weather conditions, some current construction practices, and generalized shoreline construction considerations.

Chapter 3 is general information on site design recommendations including zoning restrictions.

Chapter 4 covers structural design recommendations, examines the various forces present in the coastal environment and their ranges of magnitude, and offers some recommendations and sources of additional information. Data are also presented on various construction materials. Figure 1 (Fig. 25 on page 42 of the FEMA Manual) is an example of the type of information provided.

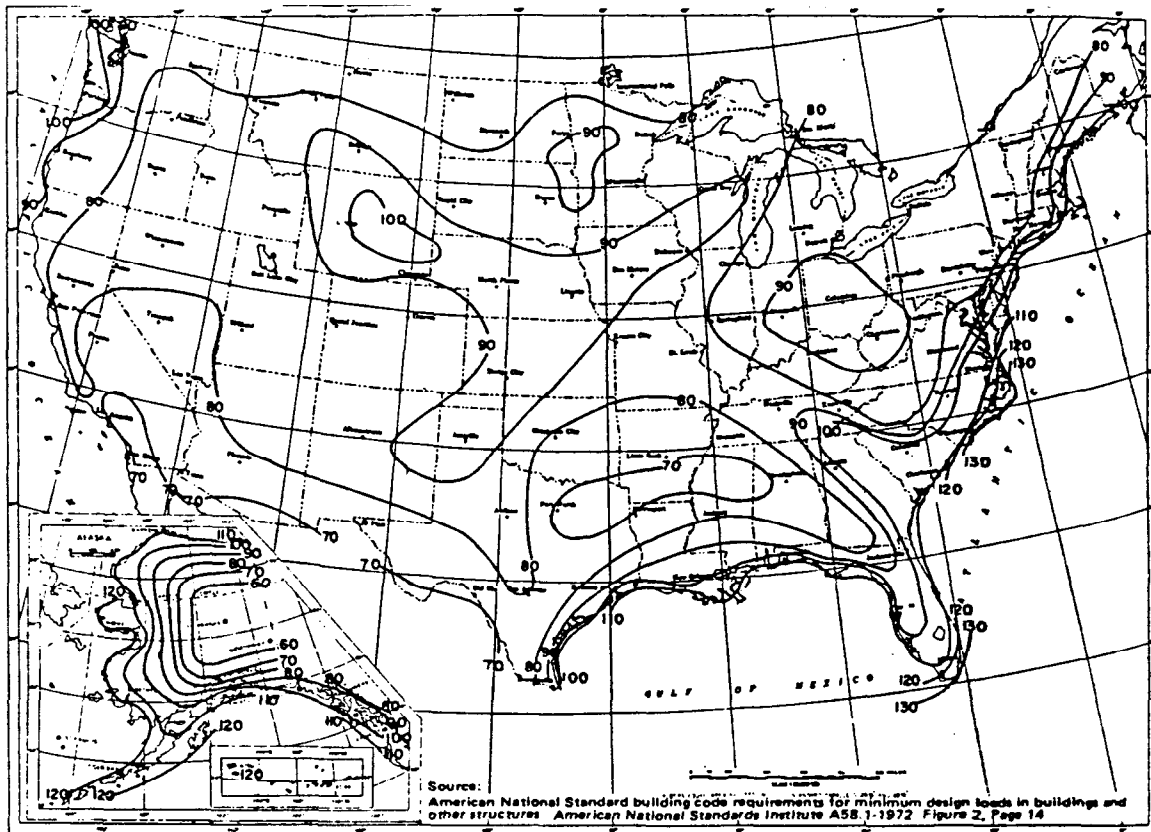


Figure 1. Annual Extreme Fastest Wind Sped in Miles Per Hour 30 Feet Above Ground, 100-Year Mean Recurrence Interval

Chapter 5 gives some additional design considerations. This information is helpful but not as critical as the material in Chapter 4. Figure 2 (Fig. 96, page 82 of the FEMA Manual) gives an example.

Chapter 6 presents a design example which details the step-by-step procedure for using the data and design tables in Appendix A of the FEMA Manual.

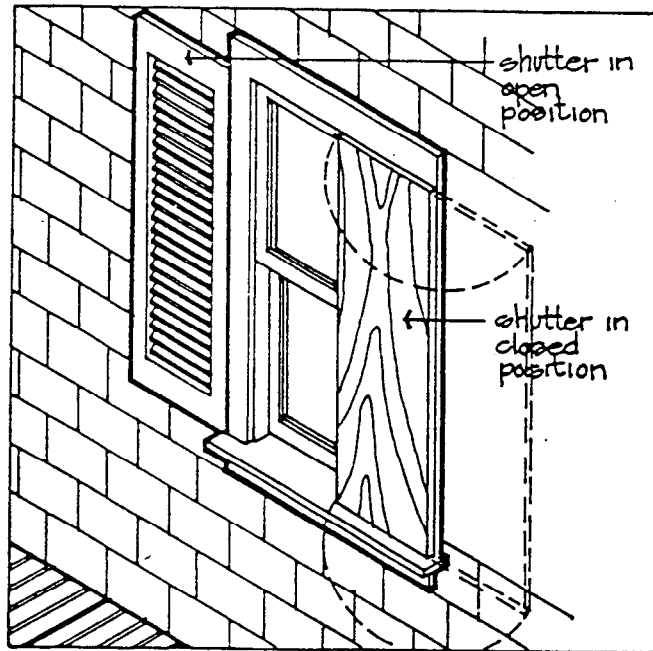


Figure 2. Shutters For Window Protection

Chapter 7 has information on construction costs. The methods and materials recommended can be expected to increase costs of construction in coastal areas over conventional construction. The requirement that the main structural supporting member be elevated above the 100-year storm elevation contributes most to the increased costs. The percentage of increase in cost of elevating structures (assuming elevation 16 to 20 feet) are estimated as follows:

Elevation by wood piles	15 to 25%
Elevation by masonry piers or walls	15 to 35%
Elevation by concrete piles	15 to 35%
Elevation by earthfill	More than 35%

Elevation by earthfill is not permitted for meeting requirements of the National Flood Insurance Program; using this method will increase costs more than 35% for a single building, but it is more economical for larger numbers of buildings.

Appendices A through F give design data tables, bracing details, references, and other pertinent information, as shown in Figure 3 (Fig A-1, page 103 of the FEMA Manual) from which the number of piles required for each dimension at a small building can be obtained. Spacing is assumed

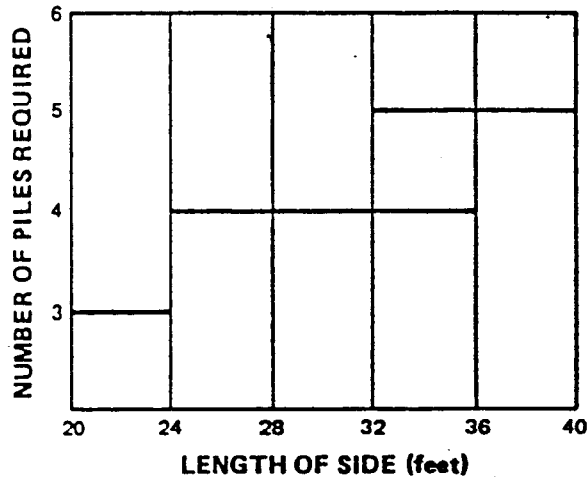


Figure 3. Number of Piles
Required in Each Row

to be equal: 8 feet at minimum, and 12 feet at maximum.

REFERENCES:

- JONES, C. P., and JOHNSON, L. T., "Coastal Construction Practices," Marine Advisory Bulletin, MAP-23, Florida Sea Grant College Program, University of Florida, Gainesville, FL, Jan 82.
- U. S. ARMY CORPS OF ENGINEERS, COASTAL ENGINEERING RESEARCH CENTER, Shore Protection Manual, 3rd ed., Vols. I, II, and III, Stock No. 008-022-0013-1, U. S. Government Printing Office, Washington, D. C., 1977.
- U. S. ARMY CORPS OF ENGINEERS, COASTAL ENGINEERING RESEARCH CENTER, Fort Belvoir, VA, 1981:
 CETN-III-6, "Shore Protection Selection Criteria."
 CETN-III-7, "Bulkheads - Their Applications and Limitations."
 CETN-III-8, "Seawalls - Their Applications and Limitations."
 CETN-III-9, "Revetments- Their Applications and Limitations."
- U. S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT and FEDERAL EMERGENCY MANAGEMENT AGENCY, "Design and Construction Manual for Residential Buildings in Coastal High-Hazard Areas," FIA-7, Washington, D. C., January 1981.